

When “Serious” Project Management is a Critical Business Requirement . . .

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Abstract

When “serious” project management is a critical business requirement, managers need to integrate cost, schedule and technical scope of work across the project, and apply earned value management. Learn how JPL integrated Oracle Projects with COTS software for schedule and cost management to provide a powerful tool for project managers!

Executive Summary

When “serious” project management is a critical business requirement, project managers need to integrate cost, schedule and technical scope of work across the project, and apply earned value management (EVM). Earned value is a method for project managers to objectively measure the amount of work accomplished on a project or contract, relative to the baseline plan, and to estimate total project costs and total duration of the project. But EVM is so much more than a financial tool! Managers need to make a cultural shift from viewing EVM as a mandatory financial reporting requirement to viewing it as a valuable and fundamental project management tool. To effectively use EVM as a management tool, it must be an integrated part of program and project management. But how can this integration occur, and what tools can be used to facilitate it?

When managers and developers at the Jet Propulsion Laboratory (JPL) grappled with these issues and the NASA requirement to apply EVM, they knew that their project managers would need a powerful, user-friendly cost management/EVM system that was integrated with their existing Oracle business system. The objectives for this system were to:

1. allow project management teams to develop, manage and analyze budgets, actual costs, variances, and forecasts, and measure performance
2. avoid the need to re-enter data from the CM/EVM system into the existing Oracle business system
3. ensure data integrity throughout the business system
4. facilitate project reporting from the “official books” in the existing business system
5. utilize as much commercial off-the shelf (COTS) software as possible to shorten development and enhance maintainability
6. provide consistency in passing data to/from the Oracle business system

The CM/EVM system interfaces with the existing Oracle Projects (PA), Oracle Human Resources (HRMS) and Oracle General Ledger (GL) applications and is integrated with COTS software for both schedule and cost management. It utilizes Cobra, developed by Welcom, as the cost management tool, and either Microsoft Project or Welcom Open Plan Professional as the scheduling tool. When uploading data between Oracle and these “project management” tools, the data are passed through Project Partners Project Loader, the Oracle Activity Management Gateway (AMG), and some JPL custom middleware. Data downloaded from Oracle are passed through the custom middleware only.

The system has a two-tiered user interface approach: a simple interface for general users, and a more sophisticated interface for skilled project resource administrators. It also includes detailed processes and procedures to describe how to use the new project management/EVM capabilities. Lastly, it includes a comprehensive training program to prepare users for the new procedures and tools.

This paper describes the processes, procedures, software, hardware and system architecture used to implement JPL's project management/EVM system, as well as design constraints, operational considerations, and technical challenges faced along the way. It describes the training and rollout plan required to successfully deploy it, and concludes with some lessons learned.

Background

About the Jet Propulsion Laboratory

The Jet Propulsion Laboratory (JPL), located in Pasadena, California is a non-profit federally funded research and development center (FFRDC) which is operated under contract by the California Institute of Technology (Caltech) for the National Aeronautics and Space Administration (NASA). JPL is part of the U.S. aerospace industry, and is the NASA Center for the unmanned exploration of the universe. In addition to its work for NASA, JPL conducts tasks for a variety of other federal agencies such as the Dept. of Defense, the Dept. of Transportation, the Dept. of Energy, etc. JPL has approximately 5100 employees: 4200 in the technical divisions and 900 in the administrative divisions. Its annual budget is approximately \$1.4 billion.

Scope of the Cost Management/Earned Value Management (CM/EVM) Task

The scope of the CM/EVM task includes the following:

1. definition of the business process for project resource management (PRM),
2. integration with the existing business system, which utilizes Oracle Financials 10.7 SC,
3. integration with existing custom software for cost estimation and rate tables,
4. development of some custom software for a user interface and middleware for interfacing between COTS software packages, and
5. training end users in the use of the CM/EVM system, PRM processes and EVM concepts.

Hence, this new system interfaces with the existing Oracle Projects (PA), Oracle Human Resources (HRMS), Oracle General Ledger (GL) applications, and Oracle Application Object Library (AOL), and is integrated with COTS software for both schedule and cost management. It utilizes Cobra, developed by Welcom, as the cost management/EVM tool, and either Microsoft Project or Welcom Open Plan Professional as the scheduling tool. In uploading and downloading from the Oracle Financials, data from this "cost management" tool is passed through JPL custom software, Project Partners Project Loader, and the Oracle Activity Management Gateway (AMG).

The concept for a new EVM system and project resource management process began in early 1997. Initial technical discussions began in May 1998, but the task continued on a "shoe string" as a concept study and prototype with minimal staffing and funding through the summer of 1999. Actual design and development began in October 1998 after the New Business System (NBS) went into production with an early October "Go Live" date. Development continued through January 2000, and testing and piloting will be continued through May 2000. Formal system rollout will occur in phases from June 2000 through September 2000.

At its peak the CM/EVM Integrated Product Development Team (IPDT) consisted of approximately nine (9) full-time equivalents (FTEs) with teams and personnel for systems engineering, technical services support, accounting and finance support, earned value management expertise, project resource management process support, software development, scheduling, training and documentation. Technical infrastructure support, such as networks and file services, was provided by the JPL Enterprise Information System (EIS) Project. System administration support for desktop computers was provided by the OAO/DNS Alliance, as part of the institutional subcontract for Desktop and Network Services.

CM/EVM Task History and JPL Culture and Environment

A number of factors have affected the culture and environment at JPL over the past five years. These factors have, in turn, influenced the environment in which the CM/EVM system was conceived, developed, and deployed. Five of these factors and their impacts and relevance are discussed below.

1. JPL's shift to process based management (PBM)

In early 1995, JPL shifted from a strictly matrix organization (line and project management) to a process-based management approach. As part of this shift, seven (7) high level domains that covered the scope of work performed at JPL were identified, along with their associated sub-domains, processes and sub-processes. One of the domains, called Develop New Products (DNP), has a process called the Project Leadership Process (PLP) which includes a number of sub-processes such as Project Team Leadership, Project Planning and Integration, Risk-Based Project Assurance, Project Cost Estimation, Project Resource Management, etc. The identification of these domains and the subsequent definition of their associated processes and sub-processes clarified many aspects of the JPL project management process, and set the stage for a more standard approach to their application and implementation. Of special importance to the CM/EVM task was the definition of the Project Resource Management (PRM) process (described in detail in the next section), since it forms the basis of the CM/EVM business rules and the operational approach. Also, another component of the process based management approach involved the creation of the Project Resource Administration Division (PRAD), an organization to which all Project Resource Administrators (PRAs) were assigned. This reorganization facilitated the training of the PRAs and the standardization of various processes and techniques.

2. A recent history of major reengineering activities at JPL and recent certification for ISO 9000

In response to NASA's desire for "faster, better, cheaper" missions, JPL has sponsored five major enterprise-wide reengineering activities since 1995. These activities encompassed the areas of institutional documentation, human resources or people processes, business processes, engineering processes and system services (such as networks, file services, directory services, data services, etc.) Also JPL spent two years preparing for an ISO 9000 Certification Audit in March 1999 and successfully received an ISO certification. These activities set the stage for examining the institutional approach to each of these areas, and in several cases, resulted in new institutional systems based on powerful technology, often with Web-enabled interfaces. The availability of these new systems and services served as a foundation on which the CM/EVM system could be built. One such system was the New Business System (NBS) which had a "Go Live" date in early October 1998. The NBS is based on the Oracle Financials and is discussed in more detail in item #6 under the CM/EVM System Architecture. Also, the subsequent business stabilization process following the NBS system rollout influenced the approach to and length of the CM/EVM system rollout.

3. New NASA Program and Project Management Processes and Requirements

In April 1998, the revised NASA Program and Project Management Processes and Requirements (NASA Procedures and Guidelines NPG 7120.5A) were published. NASA NPG 7120.5A levied new requirements for integrating and documenting project scope, schedule and budget, for defining metrics for assessing project performance, and for estimating, assessing and controlling life cycle costs. These requirements provided additional impetus and urgency for NASA Centers to develop and deploy an automated system to support complying with these requirements.

4. New NASA Prime Contract for Caltech/JPL in FY 1999

In October 1998, the five-year prime contract between NASA and Caltech/JPL was renewed. Provisions in the new NASA Prime Contract stipulated, among other things, compliance with NASA NPG 7120.5A for most types of projects at JPL and a limited requirement for use of EVM. Again, this requirement provided further impetus for developing and deploying the CM/EVM System at JPL.

5. Previous failed attempts to implement EVM systems at JPL

Since previous attempts to implement EVM systems at JPL during the 1990's failed, the CM/EVM Team was eager to understand and avoid the pitfalls and shortcomings of these earlier attempts. The history below details some of these pitfalls and shortcomings.

In the early 1990's, an attempt was made on the CRAF/CASSINI Project -- the last of the billion dollar projects at JPL -- to implement a full criteria-based earned value management system. This detailed, network schedule based system failed for several reasons, but the major contributing causes were primarily the cultural mindset and limited system functional capability. First, the technical and project management cultures at JPL were not prepared for the "new" approach using detailed network schedules. The generally held perception then was that the requisite management discipline for EVM was overly restrictive in the Laboratory's campus-like environment. Second, the tool suite selected to implement the system was not compatible with the existing

legacy business system, based on McCormick and Dodge software and hosted on a mainframe system. This system had been heavily customized to accommodate the complex funding and cost accounting models that existed, and to some degree, still exist. However, the most underrated factor in the failure of this “system” was the lack of a well-defined and accepted project resource management process. This lack of process resulted in the absence of a management framework within which the selected tool suite could operate.

In the mid-1990’s another attempt was made by the Contracts and Finance Division to implement an EVM System. After various tool sets were surveyed, demonstrated, and tested, an integrated cost/project management tool set was selected with the intention of Laboratory-wide application. However, this effort failed primarily due to poor timing since the institutional business system was in the middle of being replaced and its design was still in flux. This precluded the ability to integrate with the institutional business system and obtain financial data. In addition, the limited functional capability of the tool set and the lack of a project resource management process contributed to the cancellation of the activity.

Lastly, also in the mid-1990’s several JPL flight projects independently implemented limited earned value performance management systems due to increasing pressure from NASA sponsors. Without exception, these projects have enjoyed a significant degree of success and have greatly increased Sponsor approval. Nonetheless, the shortcomings of these “mini-implementations” were: a) none were full criteria based EVM systems; b) none were integrated with the Laboratory’s institutional business system; c) the tool set employed did not meet all of the complex funding and cost accounting models that exist; and d) there was no well-defined, Laboratory accepted project resource management process.

CM/EVM Development Constraints

Prior to 1999 all team members were part-time, “additional duty” status employees working in a “skunk works” mode. This fact, coupled with limited budget support, resulted in the following development constraints:

1. Re-engineering and process development was a priority
2. Rapid prototyping methodology
3. Severe budget constraints and limited technical assets
4. Make the system work reliably within these limits

After the definition and documentation for the PRM process were completed, the challenge of integrating or interfacing project management tool sets with Oracle Financials became the next priority task. Following four months of due diligence to find an Oracle consultant, the team convinced Project Partners, LLC to take on the technical support for our “back door” development of an integrated EVM system. The plan was to explore the development of a “hot-link” from the project/cost management tool set to Oracle Projects via Oracle’s Activity Management Gateway (AMG). Initial technical discussions in May 1998 came up empty since neither of the project management (PM) tools currently in use at JPL were Oracle CAI level partners, and were also unlikely to become partners. Immediately it became apparent that the technical task of developing a “hot-link” via the AMG with either of the existing PM tools would be prohibitively expensive in both time and resources. Also, it had already been determined that the Oracle CAI partners’ software was inadequate for JPL’s system requirements.

Subsequently one of the team members developed a three-phase strategy for achieving the required goals. Phase I consisted of developing processes for flat file downloads of monthly actual cost data from Oracle Projects. This step was a “stop-gap” measure that would allow projects using either of the PM tools to operate much as they had under the regime of the legacy system. Projects would perform their cost estimating and planning in the PM tool environment, load summary budget data into Oracle Projects via the JPL custom budgeting interface, and obtain the monthly cost data in Oracle Financials from the flat file downloads. Although this approach would involve WBS and Budget configuration management issues, and perhaps special “dummy” budget-only accounts, it would enable selected projects to operate as EVM projects after the transition to the Oracle system.

Phase II consisted of developing the processes for WBS, Budget, and Status data to be uploaded from one of the PM tools (this was to force a competitive downselect procurement during 1999) to Oracle Projects via the Oracle AMG. This step—while not a real-time “hot-link”—would minimize the WBS and Budget configuration management issues and remove the need for use of special “dummy” budget only accounts. Also, operating Phases I and II together would complete the planning/budgeting/management cycle. Projects would be enabled to estimate and plan

in the PM tool environment; to send WBS/Budget/Status data to Oracle; to receive actual cost data from Oracle; and to execute EVM-Performance Management analysis and reporting in the cost management tool environment.

While Phases I and II of this strategy were an admittedly “low tech” solution, the CM/EVM Team knew this approach would work within the development constraints. The team reviewed this approach and conceptual architecture with Project Partners personnel who immediately confirmed the overall feasibility. However, they noted the shortcoming that generating flat files of WBS and Budget data from the PM tool did not load that data into the Oracle AMG. Since Project Partners had other clients with similar needs, they agreed to take on the development of the Project Loader software module that facilitates the acceptance of flat file data by Oracle AMG via the Project Loader import tables.

Phase I was executed during the summer of 1998. The first flat file cost download software and cost repository software to support the PRM process was available for testing with the new institutional business system in October 1998. Phase II was initiated in early 1999, and final system and end-to-end testing for Phase II will be completed in mid 2000.

Phase III was to consist of a fully integrated “hot-link” of the cost management tool to Oracle Projects via the Oracle AMG. Because of the time and expense involved for Phase III, it was decided early on to complete Phases I and II, and then wait for two to three years to assess the impact of technology, especially the Web, on Oracle Financials and the third party cost management software.

Project Resource Management Process

The Project Resource Management (PRM) process integrates the functions of funds acquisition and management; project resource planning, scheduling, and cost estimating; budgeting; work agreement; work authorization and delegation; cost accumulation; performance measurement and analysis; and incorporation of revisions to baseline plan. The foregoing are accomplished in the context of the project work breakdown structure (WBS), special Laboratory facilities, and the Laboratory organization breakdown structure (OBS). The PRM process applies to all three phases of the project life cycle: the proposal phase, formulation phase and the implementation phase. See Figure 1 for a high-level data flow diagram of the PRM process, and Figure 2 for a block diagram of the PRM process.

The PRM Process consists of the following eight process elements:

1. Project Set-Up
2. Project Resource Management Guidelines
3. Integration: WBS, Oracle Account Structure, and Organization
4. Project Scheduling
5. Project Cost Estimation and Project Budgeting
6. Work Agreement and Work Authorization
7. Performance Analysis, Management and Reporting
8. Earned Value Management

The PRM process addresses Cost/Schedule Integration (or Earned Value Management) as one of its individual sub-processes. When the PRM process and its detailed procedures were first presented to project management teams at JPL, there was some cultural reluctance from team members to embrace the framework and the discipline it implies. However, as the various changes in the environment described above became reality, resistance from the management teams began to dissolve. The PRM process and the tools selected to implement the process gradually began to be viewed as key ingredients to facilitate compliance with the new, contractual realities of project management at JPL.

Figure 1 - Project Resource Management Process Data Flow Diagram

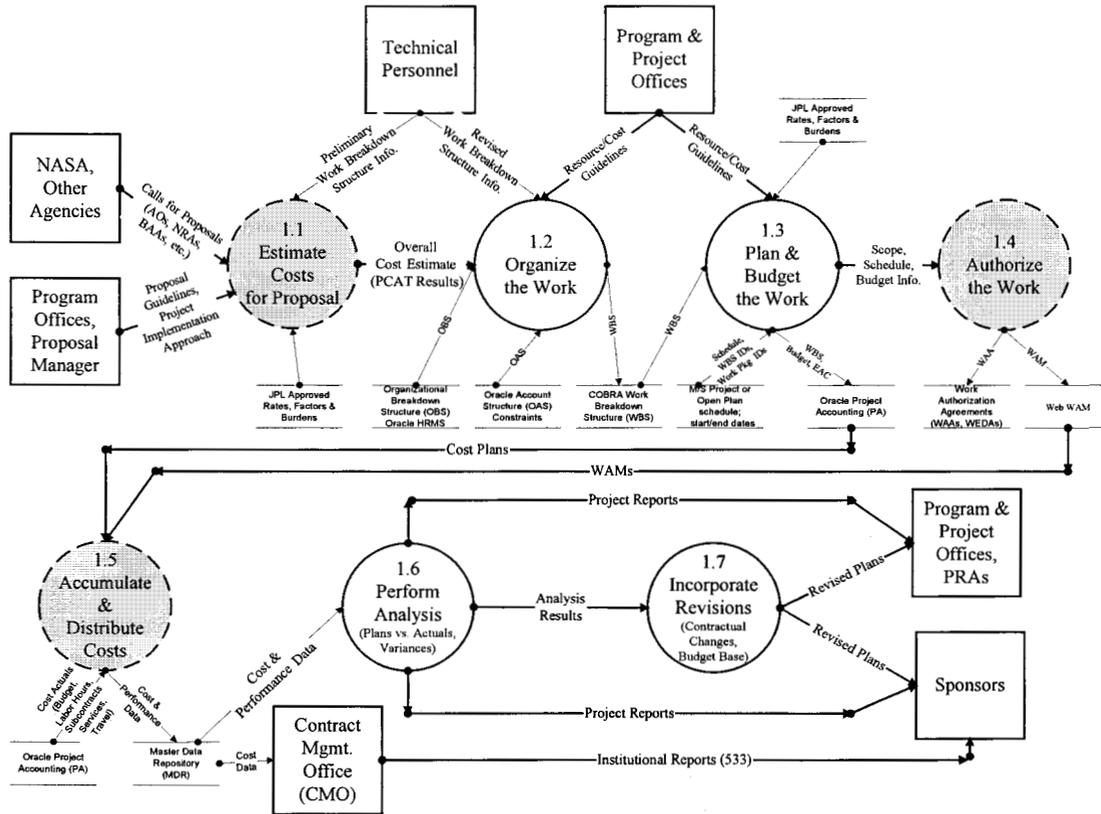
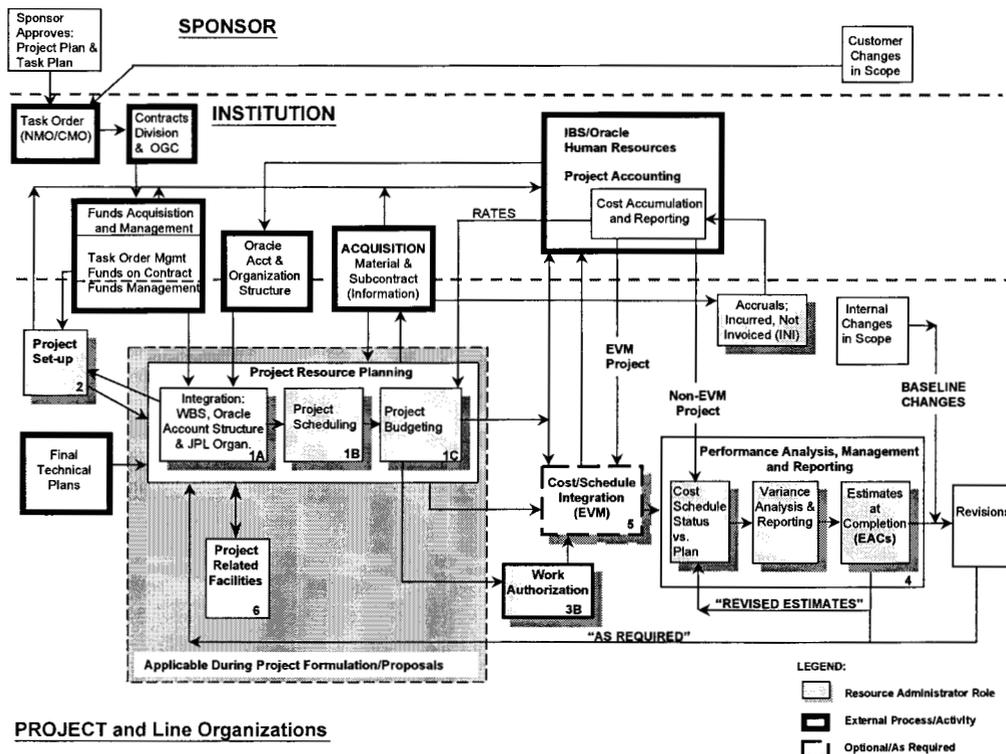


Figure 2 - Project Resource Management Process Block Diagram

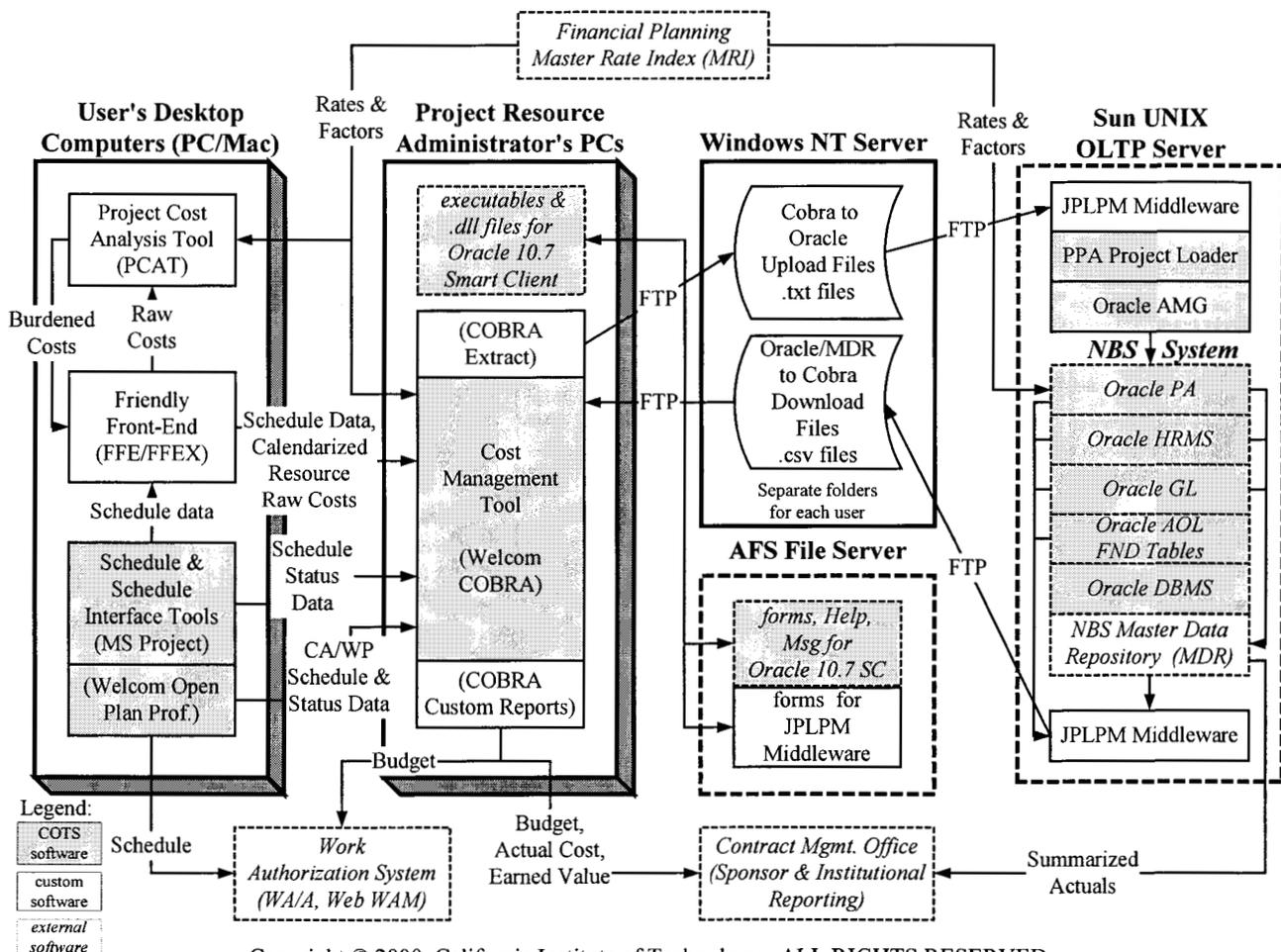


CM/EVM User Interface Approach

The system has a two-tiered user interface approach: a simple custom interface for Cost Account Managers (CAMs) or general users, and a more sophisticated interface for skilled Project Resource Administrators (PRAs). The separate Friendly Front-End (FFE/FFEX) provides a simple interface for the general user, and provides fast response time for budget calculations through a "bridge" to an existing custom Project Cost Analysis Tool (PCAT). This allows processing of cost estimates independent of the availability of the Oracle Financials and the OLTP UNIX Server. The FFE is an Excel-based application with the familiar "look and feel" and ease of use of a spreadsheet. This design facilitates copying values for a field across several months, and avoids having to enter the value separately for each cell. Another benefit is that the FFE/FFEX works on Macintosh platforms as well as PC-based computers. The FFE also includes lists of values (pick lists) for expenditure types, earned value techniques, burden schedule types and budget type. These pick lists prevent mistakes and speed up the input process since the user is selecting from available options and not entering the various types from the keyboard. The FFE allows general users to input budget information by month for labor, procurements, subcontracts, services and travel. It also allows them to generate "what if" budgets for various budget exercises.

The more complex user interface is limited to the Project Resource Administrators (PRAs). This interface provides the cost management and EVM capabilities in Welcom Cobra, as well as the upload to and download from the New Business System (NBS) based on Oracle Financials via the JPLPM Middleware. Custom Oracle forms were used for the portion of the interface associated with the upload and download capability, and the "look and feel" is similar to the Oracle Financials interface. Reserving the upload and download capability to the PRAs allows them to perform some quality checks of the inputs before they are uploaded into the NBS. It also complies with a requirement in the Oracle AMG that the user have key member status in Oracle PA.

Figure 3 CM/EVM System Block Diagram



CM/EVM System Architecture

A block diagram of the CM/EVM System showing the various platforms, software components, and data flows is given in Figure 3 on the previous page. As can be seen from the diagram, the CM/EVM System does not follow the typical client/server architecture, but is in fact, a hybrid architecture with two intermediate layers between the end-user and the actual OLTP server. Below are the salient features of the CM/EVM system architecture, following the components in the block diagram from left to right.

1. As mentioned above, there is a two-tiered user interface: the Friendly Front-End (FFE/FFEX) for general users and the more sophisticated user interface for the EVM capabilities in Welcom Cobra and the JPLPM middleware.
2. Schedule capabilities are provided through COTS schedule tools, namely Microsoft Project for schedules that are not resource loaded and Welcom Open Plan Professional for resource-loaded schedules.
3. The COTS Cost Management tool, Welcom Cobra, is supplemented by a custom extract module developed by Welcom. This module performs a custom extract from the Cobra database to allow transferring information to Oracle Projects (PA) through three data transfer modules. This extract generates seven pipe-delimited [|] text files described below. These file structures are very exacting, and flow into Oracle Projects via the data transfer software modules described below in items #7 and #9 in this section.
 - a. TASK – contains the Project number, Task number (WBS), task name, task start/end dates, and pertinent defined Oracle Projects task attributes (flex-fields).
 - b. BASELINE BUDGET HEADER – contains the Project number.
 - c. BASELINE BUDGET LINES – contains Project number, task number, resource type, fiscal period, raw cost amount, burdened cost amount, and quantity (hours).
 - d. EAC BUDGET HEADER – contains the Project number.
 - e. EAC BUDGET LINES – contains Project number, task number, resource type, fiscal period, raw cost amount, burdened cost amount, and quantity (hours).
 - f. EARNED VALUE - contains Project number, task number, fiscal period, budget, actual cost, earned value, and budget-at-completion data.
 - g. PERCENT COMPLETE - contains Project number, task number, fiscal period and Percent Complete data.
4. As part of the NBS design and rollout, the Oracle 10.7 Smart Client (SC) was split into two parts to improve performance and to facilitate software distribution and configuration management of updates. Only the static executables and .dll files for the Smart Client reside on the end-user's PC (~100 MB). The dynamic forms, Help, and Msg for the Smart Client reside on the AFS File Server (~700 MB). The CM/EVM System continued this approach, and placed the eleven (11) forms for the JPLPM Middleware on the AFS File Server as well (~3 MB).
5. A Windows NT Server is used to temporarily store files that are either being uploaded to Oracle Financials from Cobra or downloaded to Cobra from Oracle Financials or the NBS MDR. These files are transferred via FTP between the PRA's PC, the Windows NT Server, and the OLTP UNIX Server. Although these files can be transferred from the NT Server to the OLTP UNIX Server directly during "prime time," usually they are transferred via batch production jobs launched overnight by the Oracle Concurrent Manager. This feature allows processing independent of the availability of the Oracle Financials and the OLTP UNIX Server, which is especially helpful during month-end or year-end close periods.
6. The CM/EVM system has interfaces with the production instance (PRODAPP) of the existing business system at JPL (based on Oracle Financials system) called the New Business System (NBS). The CM/EVM system accesses tables in Oracle Projects (PA), Oracle Human Resources Management System (HRMS), Oracle General Ledger (GL), and the Oracle Application Object Library (AOL). See Table 1 on the next page for specifics on the tables being accessed.

Table 1 Database Tables Read and Updated by the CM/EVM System

Module	Read or Update	Table Name
Oracle AOL FND	Read	FND_DESCR_FLEX_COL_USAGE_VL FND_FLEX_VALUE_SETS FND_FLEX_VALUE_SETS_VL FND_NEW_MESSAGES FND_RESPONSIBILITY FND_USER FND_USER_RESPONSIBILITY
Oracle GL	Read	GL_PERIODS
Oracle HRMS	Read	HR_ORGANIZATION_UNITS HR_ORGANIZATION_INFORMATION JPLPER_INTERFACE_FROM_X500 PER_ASSIGNMENTS_F PER_ORG_STRUCTURE_ELEMENTS PER_PEOPLE_F
Oracle PA	Read	PA_EMPLOYEES PA_PERIODS PA_PROJECT_PLAYERS PA_RESOURCES PA_RESOURCE_ASSIGNMENTS PA_RESOURCE_LIST_MEMBERS
Oracle PA	Update	PA_BUDGET_LINES PA_BUDGET_VERSIONS PA_PROJECTS_ALL PA_TASKS
PPA Project Loader	Update	PPA_TASKS_XFACE PPA_BUDGETS_XFACE PPA_BUDGET_LINES_XFACE
NBS MDR	Read	JPLFUNC_ACCUM_MONTH_COST JPLFUNC_ACCUM_MONTH_WORKFORCE JPLFUNC_ACCUM_LAST_RUN

7. COTS software, namely the Project Partners Application (PPA), Project Loader, and the Oracle Activity Management Gateway (AMG), are used to transfer data to the Oracle Financials. This provides some “insulation” from the actual schema for the Oracle modules, enforces Oracle business rules, and saves development and maintenance time and costs.
8. The CM/EVM System downloads data from the NBS Master Data Repository (MDR) which was created as part of the NBS development. The MDR extracts and summarizes four different types of GL-posted cost transactions: unpaid invoices, encumbrances, requisitions and actuals. The MDR summarizes costs by project, task, expenditure type, PO number, and BCID level, by week and by month, and maintains balances for week-to-date, month-to-date, year-to-date and inception-to-date. It was developed to provide a single source of data for reporting, and to resolve the differences that arose initially when ad-hoc reports were generated at different times. The MDR is updated nightly from the NBS production instance.
9. Custom software called “JPLPM Middleware”, developed at JPL using Oracle Developer 2000 (Oracle Forms and Reports), PL/SQL, SQL+, and UNIX scripts, provides the following capabilities:
 - a) Provide on-line forms to submit uploads, downloads and manage the JPLPM application
 - b) Convert JPL projects to Cobra format.
 - c) Upload, validate, and populate the PPA Project Loader import tables with WBS, budget and EAC data. Update the Budget Accum tables. Send e-mail alerts when errors are found.
 - d) Download existing WBS and Budget from Oracle Projects (PA) to Cobra.
 - e) Download Cobra actual costs and obligations from the NBS Master Data Repository (MDR).

- f) Download Cobra Global files from Oracle PA, HRMS and AOL FND.
- g) Perform JPLPM housekeeping and reporting.

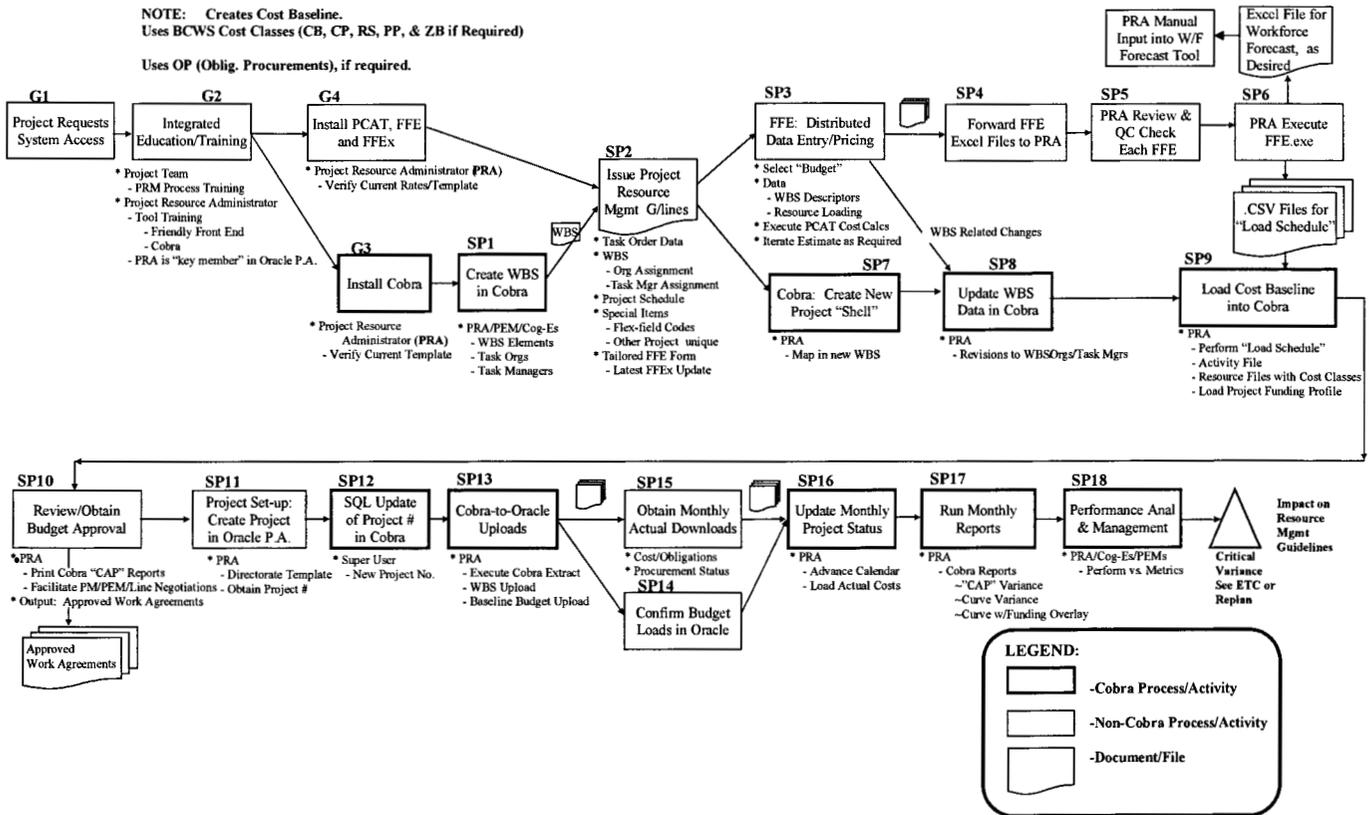
Another important function provided by the JPLPM software is to enforce the business rules of the JPL Project Resource Management (PRM) process. For example, while Oracle PA may allow a task start date before a project start date, the JPL PRM process will not allow this, and will generate an error message. The PRA must then “clean up” this data in Oracle PA before the JPLPM software will allow uploads.

- 10. Security features are an integral part of the CM/EVM system, and are handled through the use of user IDs and passwords; Cobra security features; Windows NT file server logon and authentication; and Oracle applications security via Oracle IDs, roles, and responsibilities in Oracle PA.

CM/EVM Operational Scenarios

Operational scenarios were developed in order to define how the CM/EVM system elements would work in the context of the Project Resource Management process. Initially scenarios for both earned value and non-earned value use of the CM/EVM system were defined and mapped into diagrams. The five non-earned value scenarios included: migrate existing project from Oracle, new project baseline, re-planned baseline for non-project applications inside of Cobra, revised project baseline outside of Cobra, and Estimate-to-Complete/EAC outside of Cobra. The three earned value scenarios included: new project baseline, revised project baseline and estimate-to-complete/EAC outside of Cobra. These scenarios were used to validate the approach to testing, training and system operations. Test scripts and training script materials were mapped to each item in the scenario. Collectively the scenarios provided the framework for overlaying the PRM processes on various operational situations. See Figure 5 for an example of the operational scenario for the non-EVM New Project Baseline.

Figure 4 Operational Scenario for the New Project Baseline (Non-EVM)



CM/EVM Training Approach

The CM/EVM training approach is to provide a course curriculum that integrates training about the project resource management process and Earned Value concepts with training for the CM/EVM System itself. The course curriculum includes an overview of the Project Resource Management (PRM) process and the NASA Program and Project Management Processes and Requirements (NASA NPG 7120.5A). In addition, tailored education and training is being developed for the different participants in the PRM Process which includes Project Managers, Project Element Managers (PEMs), Cost Account Managers (CAMs), Task Managers, Project Resource Administrators (PRAs), and Line Administrators. The tailored training includes case studies based upon operational scenarios, which integrate the PRM process with the CM/EVM system. Training will be conducted just in time for each project or task, approximately two weeks before they are scheduled to deploy the CM/EVM system.

The CM/EVM Training Team is a cross-functional team led by a Training Manager, and includes subject matter experts, personnel from JPL Professional Development, a Training Coordinator, and a Curriculum Developer. The training modules vary from 4 hours to train a Cost Account Manager to 4 days (32 hours) to train a Project Resource Administrator. In addition, subject matter experts will be available to assist projects and tasks in their conversion to and deployment of the CM/EVM system.

CM/EVM Rollout Strategy and Plan

The CM/EVM System is being deployed in a phased manner with a carefully constructed rollout strategy. The first step in the strategy was to select a few Projects in the early Formulation Phase for a Wave I Pilot, and then work with them over a couple of months to deploy the CM/EVM process and tools for use on their projects. Once these projects successfully demonstrated portions of the system's capability, this created positive test cases that were viewed favorably by the JPL project management community.

Next, a few strategic Flight Projects were selected for a Wave II Pilot for initial migration to the CM/EVM system and associated Project Resource Management Processes. Again, the team worked with these projects for a couple of months to assist in the deployment. Throughout these pilots, the CM/EVM system was upgraded based on user's feedback and experience. Also, formal training material is being created to capture the "lessons learned" and to facilitate a broader rollout.

A period of six to seven months is planned for Wave III to convert 34 Flight and Instrument Projects to using the CM/EVM system. Lastly, Wave IV will include deployment for the remaining Program Directorates and tasks at the laboratory. The timeframe for the phased deployment of the CM/EVM System spans from November 1999 through September 2000. The rationale for this strategy is to build on our successes. Since JPL is comprised of multiple Program Directorates with varying degrees of rigor employed in the management of tasks, gradual deployment is crucial. By building on their successes, the CM/EVM Team will be able to demonstrate the added value of both the PRM process and the CM/EVM system to the user community.

CM/EVM Technical and Logistical Challenges

The CM/EVM Task faced a number of technical and logistical challenges in developing and deploying the CM/EVM System. Five of these challenges are described in more detail below.

1. Integrating the CM/EVM System with the JPL organization hierarchy in Oracle HRMS

For the past 30 years, JPL has used a "smart" numbering system for identifying organizations. For example, Section 389 is in Division 38 – the first two digits of the section number are the division number. Over the years, these "smart" numbers have changed their meaning as JPL has gone through numerous reorganizations. The organization numbers began to be reused, and in some cases, there were up to five occurrences of the same organization number. To alleviate this problem, the CM/EVM team built a mapping table in Oracle where the unique Oracle organization ID could point to a JPL organization number that was extended with a sequence number. This sequence number guarantees uniqueness, and at the same time, allows the users to see the "smart" numbers to which they are accustomed.

2. Integrating the CM/EVM System with JPL's business system and their use of Oracle PA

Since the CM/EVM System is integrated with JPL's New Business System (NBS) based on the Oracle Financials, it is always impacted by any changes to expenditure types or flex fields in Oracle PA. It became necessary for the CM/EVM Team to have a member on the NBS Configuration Control Board to participate in and be aware of any forthcoming changes to these fields, and to provide information to the Project Accounting Team regarding any potential impacts.

3. Uncovering data integrity issues in the existing NBS system by enforcing business rules

Since the JPLPM Middleware enforces Oracle business rules and JPL-specific business rules for the project resource management process, it uncovered a significant amount of incorrect or corrupt data residing in the NBS database. Hence, use of the JPLPM Middleware performed de facto independent verification and validation (IV&V) of the Oracle Projects database. However, not all rules convey the same penalty if they are broken. Violation of some rules causes uploads to be rejected, while violation of other rules carry only warnings. Each rejection and warning message is automatically e-mailed to the user using the JPLPM Middleware. Some of the critical data required cleanup prior to switching to the CM/EVM system. The JPLPM Middleware ran edits and tests of the data in Oracle Projects to ensure that the JPL Project Resource Management process and the Cobra tool business rules were enforced. As data on existing projects was downloaded from Oracle, it was important that it not "fail" as it was downloaded into Cobra. The Oracle AMG enforces some Oracle business rules on the upload side. Again, it was important that the data generated in the Cobra extract would not "fail" as it was uploaded to Oracle projects.

4. Performing Configuration Management of CM/EVM Components

Since the CM/EVM system has various software components (FFE/FFEX, PCAT, Schedule tools, and Cobra) that reside on the user's desktops, configuration management of this software is an issue. Also, synchronizing the Master Rate Index (MRI) across three applications (PCAT, Cobra, and Oracle PA) needs to be coordinated as well. The CM/EVM Team generated a Configuration Management Plan, formed its own Configuration Control Board (CCB), implemented its own configuration management system, and hired a part-time Configuration Management Coordinator (CMC) to oversee this process.

5. Managing the tables in the JPLPM Middleware

In order to effectively manage the tables in the JPLPM Middleware and not use inordinate amounts of disk space over time, the JPLPM Middleware was designed to have three types of tables: permanent tables, managed tables and "life of process" tables. Permanent tables are used to control the application. They contain such things as lists of projects that are authorized to do uploads and downloads, and various business rule enforcement parameters controlled by the JPL process owner. Managed tables are specifically used for logging messages and e-mail alerts that are sent to users and application support personnel. These messages are kept for approximately seven days and then are purged without archiving. "Life of process" tables are the import tables used between the JPLPM Middleware and the PPA Project Loader. They are purged after each upload or download.

CM/EVM Lessons Learned

Below is a summary of the lessons learned during the design, development and deployment of the CM/EVM System. While they are mostly common sense, it never hurts to be reminded of what to expect, or to learn what worked for someone else, or to be warned about what to watch for and avoid.

1. Importance of process definition before system implementation.

Historical experience at JPL and common sense both showed the importance of having integrated project resource management processes in place before defining a project management system or selecting a project/cost management tool. Defining these processes gave JPL the framework of "plug-and-play" capability for any competent tool that satisfied basic project management requirements.

2. Processes, procedures, documentation and training are important contributors to a successful rollout

Just as one cannot build a house without a foundation and framework, the success of the CM/EVM system has depended on the development of effective and integrated processes, procedures, documentation and training. Focusing on one to the exclusion of the others will not bring success.

3. Importance of operational scenarios for use in testing, training, and actual system operations

It was imperative that the CM/EVM system elements work in the context of the Project Resource Management process. Developing operational scenarios provided the framework necessary for integrating test scripts, training scripts, and operational user manuals. The experience of the CM/EVM Team indicates that one cannot get too much process, process, and more process!

4. Benefits of prototyping, piloting, and getting user involvement and feedback

We all know that one cannot complete the “sale” until the customer wants to buy. Prototyping, piloting, and end-user involvement early in the development cycle ensured “buy-in” by the intended user community. Although certain aspects of this approach added to the short-term workload of the team members, this cost was far outweighed by the benefits of risk reduction and the resulting peace of mind that were achieved.

5. User friendliness and accessibility are important for broad usage and acceptance

JPL’s user community clearly vocalized the importance of user friendliness and easy system access. Hence, the “buy-in” obtained and discussed in item #4 above would not have occurred without this characteristic.

6. “Skunk works” approach and skilled team facilitated success.

Just as the “skunk works” paradigm has worked successfully at other organizations, it also worked at JPL. In addition, ensuring that key skills and sufficient expertise are available across the whole spectrum of the problem domain is an essential component of success. The team was comprised entirely of senior personnel, and had a balanced skills mix. First, it is critical to select process developers with wide-and-deep experience in project management, business systems, and institutional and customer financial models. This expertise will ensure that subtle nuances of process and approach are considered and incorporated into the system design. Second, it is essential to obtain software engineers with the skill and experience that includes the relevant software languages, hardware/software platforms, and networks. Third, it is important to select a team leader with strong “people” skills and a precise vision of where the team needs to go. Lastly, it is important to select a system engineer with a solid understanding of methodologies and processes and an ability to understand issues of system integration, transition and operations.

7. Need to allocate time for cleanup of the Oracle Projects database

Since use of the JPLPM Middleware enforces business rules, it disclosed a significant amount of incorrect or corrupt data residing in the NBS database. Some of the critical data required cleanup prior to switching to the CM/EVM System. Hence, time needed to be allocated in the rollout schedule for this cleanup before an existing Oracle project could convert to the CM/EVM system.

8. Scope of training required for successful deployment and use

Simply providing training on the use of the CM/EVM tools was not adequate. The newness of the PRM process and the CM/EVM system required a two-tiered approach to training. First, entire project teams were educated about the system and its supporting processes. Then appropriate tool-specific training for task managers, line organization administrators, and project resource administrators was provided.

9. Timing is everything!

Occasionally even having the correct “widget” for the job is insufficient to gain the resources and management support that are required to move forward with a task. Sometimes it takes special circumstances or a confluence of factors to galvanize or legitimize an activity and a new way of doing things. The new NASA project management requirements, the new NASA prime contract, the ISO 9001 certification requirement, all converged at or about the same period in JPL history to create the seminal process that facilitated and ensured the success of the CM/EVM team.

10. Benefits of use of COTS software for schedule capabilities, cost management and EVM, and data transfer

Since project and performance management as a discipline has been around for over 30 years, a number of tools are commercially available. Also, since APIs were available from Oracle, it would not have been cost-effective to replicate this work. Even though all of the COTS tools required some process tailoring or JPL-specific “templates,” the alternative of developing a fully integrated, custom system was never seriously considered since it would have involved two to three years development time and \$3 to \$5 million development costs.

Summary

The CM/EVM System is providing both an integrated process and an automated system to project managers and project resource administrators for integrating cost, schedule and technical scope of work across their projects, and applying earned value management if needed. By integrating with the existing business system based on the Oracle Financials, and by using as much commercial off-the-shelf software as possible, a small core team built the system for a relatively low cost. By using a prototyping development approach in a “skunk works” environment along with user involvement and feedback throughout, the CM/EVM Team ensured user “buy in” and acceptance. Detailed definition of the Project Resource Management Process before system implementation, and subsequent generation of corresponding operational scenarios facilitated the approach to training, testing and system operations. Utilizing a phased rollout approach ensures that project teams obtain the necessary training and support to successfully transition to the new process and tools. With the new CM/EVM System in place, JPL can meet its requirements for “serious” project management with confidence!

About the Presenters

P. A. “Trisha” Jansma served as the Systems Engineer for the Cost Management/Earned Value Management (CM/EVM) System during the implementation phase and transition to production. She supported the CM/EVM Team with various systems engineering tasks and processes. Trisha has a broad background in systems and software engineering and information technology, both in an engineering environment, and also in a business environment. She has worked with the Oracle Financials and HRMS for almost four years. Trisha has a B.A. in Mathematics from Point Loma Nazarene University, an M.S. in Computer Science from the University of Southern California, and an Executive M.B.A. from the Peter Drucker Management Program at Claremont Graduate University.

L. Bruce Gibby served as the process engineer and functional architect for the CM/EVM system during initial concept phase, design phase, development phase, implementation phase, and transition to production. He has extensive industrial and consulting experience in project controls, project management, and business systems development. He has worked for two years on the integration of third party project management tools with Oracle Projects at JPL. He holds a B.A. in Political Science from Occidental College, an M.B.A. in Finance from the University of California at Los Angeles, and a Ph. D. in International Business and Comparative Management from the University of California at Los Angeles. Bruce was a Howard Hughes Staff Fellow and NDEA Title IV Fellow during his time at UCLA.

Calvin R. Chambers served as the CM/EVM Team Leader from conception through development and as the Deputy Task Manager during implementation and transition to production. He has been involved with the development of project management practices for JPL since joining the Laboratory in 1992. Currently he is the Section Manager of the Project Resource Management Section, and the Process Owner for the Project and Institutional Resource Management Processes. He is also a member of JPL’s Reengineering Team for Develop New Products (DNP) Project Leadership Process (PLP), and serves as JPL’s representative to the NASA Earned Value Focal Point Council. Prior to joining JPL, he spent ten years with Lockheed Aeronautical Systems Company and its subsidiary, Advanced Development Company, working in a variety of related proposal and project support roles. Cal has a B. A. in Business Administration and Finance from California State University, Northridge.

J. Steve Joines served as the software engineer and lead developer for the CM/EVM System during the design phase, development phase, implementation phase, and transition to production. He designed and developed the JPLPM Middleware software, and the security approach. He has worked with the Oracle Financials and HRMS for two years. Steve has a B. S in Business Administration and Information Systems from California Polytechnic State University, Pomona.

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